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(12) United States Patent
Shaheen

(10) Patent No.: US 9,826,443 B2
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(54) **METHOD AND APPARATUS FOR SUPPORTING HANDOVER FROM LTE/EUTRAN TO GPRS/GERAN**

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(73) Assignee: **InterDigital Technology Corporation**, Wilmington, DE (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/311,277**

(22) Filed: **Dec. 5, 2011**

(65) **Prior Publication Data**

US 2012/0077500 A1 Mar. 29, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/029,532, filed on Feb. 12, 2008, now Pat. No. 8,072,936.

(Continued)

(51) **Int. Cl.**

H04W 4/00 (2009.01)
H04W 36/00 (2009.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04W 36/0061*** (2013.01); ***H04W 36/0011*** (2013.01); ***H04W 36/0022*** (2013.01); ***H04W 36/12*** (2013.01); ***H04W 36/14*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,308,267 B1 * 10/2001 Gremmelmaier H04W 8/06 370/329
6,845,238 B1 1/2005 Muller

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1354963 6/2002
JP 2001-197539 7/2001

(Continued)

OTHER PUBLICATIONS

Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS); Service description; Stage 2 (Release 7)," 3GPP TS 23.060 V7.3.0 (Dec. 2006).

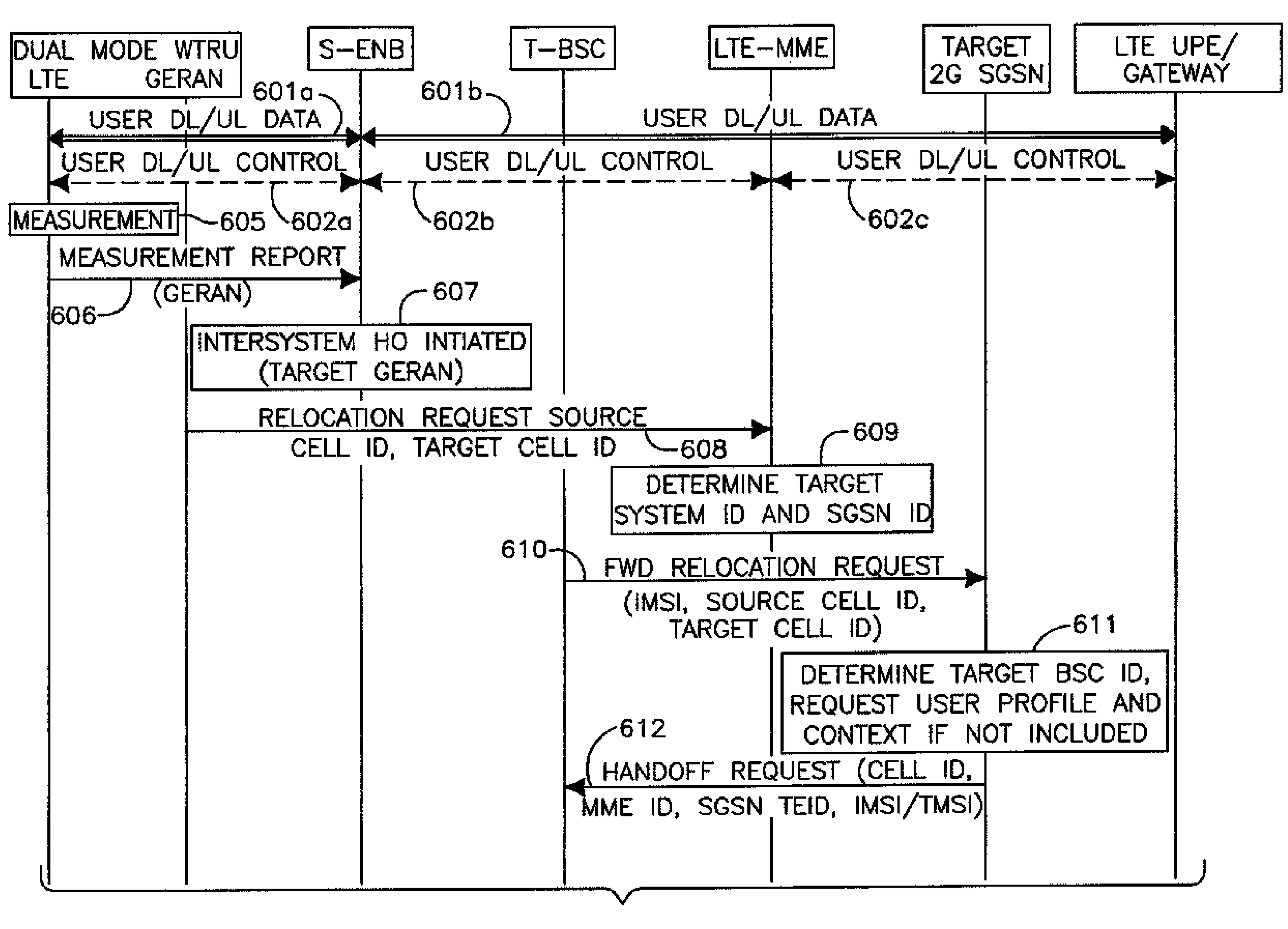
(Continued)

Primary Examiner — Alpus H Hsu
(74) *Attorney, Agent, or Firm* — Quasim A. Shah

(57) **ABSTRACT**

A method for use in a source long term evolution (LTE) mobility management entity (MME) and an MME are disclosed. The method includes receiving a relocation request from an evolved Node B (eNB), determining a handover target global system for mobile (GSM)/enhanced data rates for GSM evolution (EDGE) radio access network (GERAN) system for a handover of a wireless transmit/receive unit (WTRU) based on the received relocation request, identifying a serving General Packet Radio Service (GPRS) support node (SGSN) that controls a target GERAN cell, and forwarding the relocation request to a target SGSN.

7 Claims, 11 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 60/889,383, filed on Feb. 12, 2007.

(51) **Int. Cl.**

H04L 12/28	(2006.01)
H04W 36/14	(2009.01)
H04W 36/12	(2009.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,901,257	B2	5/2005	Kubota	
7,003,297	B2	2/2006	Willars et al.	
7,466,652	B2 *	12/2008	Lau	H04L 41/0866 370/230.1
7,778,641	B1	8/2010	Willars et al.	
7,809,373	B2	10/2010	Park et al.	
8,023,467	B2	9/2011	Wu et al.	
8,032,133	B2 *	10/2011	Niemela	H04W 48/18 370/328
8,072,936	B2	12/2011	Shaheen	
8,644,247	B2 *	2/2014	Madour et al.	370/331
8,817,758	B2 *	8/2014	Fox	H04W 84/042 370/336
2004/0266438	A1	12/2004	Bjelland et al.	
2005/0130659	A1 *	6/2005	Grech	H04L 63/08 455/436
2005/0249188	A1	11/2005	Hayashi	
2006/0276190	A1	12/2006	Shaheen	
2007/0019575	A1	1/2007	Shaheen	
2007/0019643	A1	1/2007	Shaheen	
2007/0021120	A1	1/2007	Flore et al.	
2007/0213060	A1 *	9/2007	Shaheen	455/436
2007/0248064	A1	10/2007	Shaheen	
2008/0013553	A1	1/2008	Shaheen	
2008/0098467	A1 *	4/2008	Miller et al.	726/5
2008/0102896	A1	5/2008	Wang et al.	
2008/0130578	A1	6/2008	Wang et al.	
2008/0181178	A1	7/2008	Shaheen	
2009/0073933	A1 *	3/2009	Madour et al.	370/331
2010/0061340	A1 *	3/2010	Ramle	H04W 36/12 370/331
2011/0122839	A1 *	5/2011	Rexhepi	H04W 36/12 370/331

FOREIGN PATENT DOCUMENTS

JP	2002-541747		12/2002
JP	2003-509982		3/2003
KR	2001-0108453		12/2001
WO	98/06226		2/1998
WO	0038465	A1	6/2000
WO	00/60895		10/2000
WO	01/67788		9/2001
WO	2005/060296		6/2005
WO	WO 2005/089249		9/2005
WO	2005/096560		10/2005
WO	WO 2006/112561		10/2006
WO	2006125085	A2	11/2006
WO	2006/130058		12/2006
WO	2007/007990		1/2007
WO	2007007990	A1	1/2007
WO	WO 2007/011983		1/2007

OTHER PUBLICATIONS

Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS); Service description; Stage 2 (Release 7)," 3GPP TS 23.060 V7.6.0 (Dec. 2007).

Third Generation Partnership Project, "Technical Specification Group Core Network and Terminals; Customised Applications for Mobile network Enhanced Logic (CAMEL) Phase 4; Stage 2 (Release 7)," 3GPP TS 23.078 V7.6.0 (Dec. 2006).

Third Generation Partnership Project, "Technical Specification Group Core Network and Terminals; Customised Applications for Mobile network Enhanced Logic (CAMEL) Phase 4; Stage 2 (Release 7)," 3GPP TS 23.078 V7.9.0 (Sep. 2007).

Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; Intra-domain connection of Radio Access Network (RAN) nodes to multiple Core Network (CN) nodes (Release 7)," 3GPP TS 23.236 V7.0.0 (Dec. 2006).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Radio interface protocol aspects (Release 7)," 3GPP TR 25.813 V7.1.0 (Sep. 2006).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode (Release 8)," 3GPP TS 36.304 V8.0.0 (Dec. 2007).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Resource Control (RRC); Protocol specification (Release 8)," 3GPP TS 36.331 V8.0.0 (Dec. 2007).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical layer—Measurements (Release 8)," 3GPP TS 36.214 V0.1.0 (Oct. 2006).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management (Release 8)," 3GPP TS 36.133 V8.0.0 (Dec. 2007).

Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access (Release 8)," 3GPP TS 23.401 V8.0.0 (Dec. 2007).

Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; 3GPP System Architecture Evolution: GPRS enhancements for LTE access; Release 8," 3GPP TS 23.401 V0.1.0 (Jan. 2007).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer—Measurements (Release 8)," 3GPP TS 36.214 V8.1.0 (Nov. 2007).

Third Generation Partnership Project, "Technical Specification Group GERAN; Packet-switched handover for GERAN A/Gb mode; Stage 2 (Release 6)," 3GPP TS 43.129 V6.10.0 (Nov. 2006).

Third Generation Partnership Project, "Technical Specification Group GERAN; Packet-switched handover for GERAN A/Gb mode; Stage 2 (Release 6)," 3GPP TS 43.129 V6.12.0 (May 2007).

Third Generation Partnership Project, "Technical Specification Group GSM/EDGE Radio Access Network;Packet-switched handover for GERAN A/Gb mode; Stage 2 (Release 7)," 3GPP TS 43.129 V7.0.0 (Nov. 2006).

Third Generation Partnership Project, Technical Specification Group GSM/EDGE Radio Access Network; Packet-switched handover for GERAN A/Gb mode; Stage 2 (Release 7)3GPP TS 43.129 V7.2.0 (May 2007).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Radio interface protocol aspects (Release 7)," 3GPP TR 25.813 V7.0.0 (Jun. 2006).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC) protocol specification (Release 1999)," 3GPP TS 25.331 V3.21.0 (Dec. 2004).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 4)," 3GPP TS 25.331 V4.17.0 (Mar. 2005).

(56) **References Cited**

OTHER PUBLICATIONS

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 4)," 3GPP TS 25.331 V4.18.0 (Dec. 2007).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 5)," 3GPP TS 25.331 V5.19.0 (Dec. 2006).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 5)," 3GPP TS 25.331 V5.21.0 (Dec. 2007).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 6)," 3GPP TS 25.331 V6.12.0 (Dec. 2006).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 6)," 3GPP TS 25.331 V6.16.0 (Dec. 2007).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 7)," 3GPP TS 25.331 V7.3.0 (Dec. 2006).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 7)," 3GPP TS 25.331 V7.7.0 (Dec. 2007).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 8)," 3GPP TS 25.331 V8.1.0 (Dec. 2007).
Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS); Service description; Stage 2 (Release 1999)," 3GPP TS 23.060 V3.17.0 (Dec. 2006).
Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS); Service description; Stage 2 (Release 4)," 3GPP TS 23.060 V4.11.0 (Dec. 2006).
Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS); Service description; Stage 2 (Release 5)," 3GPP TS 23.060 V5.13.0 (Dec. 2006).
Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS); Service description; Stage 2 (Release 6)," 3GPP TS 23.060 V6.15.0 (Dec. 2006).
Third Generation Partnership Project, "Technical Specification Group Core Network; Customised Applications for Mobile network Enhanced Logic (CAMEL) Phase 3—Stage 2 (Release 1999)," 3GPP TS 23.078 V3.19.0 (Mar. 2004).
Third Generation Partnership Project, "Technical Specification Group Core Network; Customised Applications for Mobile network Enhanced Logic (CAMEL) Phase 3—Stage 2 (Release 4)," 3GPP TS 23.078 V4.11.1 (Apr. 2004).
Third Generation Partnership Project, "Technical Specification Group Core Network and Terminals; Customised Applications for Mobile network Enhanced Logic (CAMEL) Phase 4; Stage 2 (Release 5)," 3GPP TS 23.078 V5.11.0 (Jun. 2006).
Third Generation Partnership Project, "Technical Specification Group Core Network; Customised Applications for Mobile network Enhanced Logic (CAMEL) Phase 4; Stage 2 (Release 6)," 3GPP TS 23.078 V6.9.0 (Dec. 2006).
Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; Intra-domain connection of Radio Access Network (RAN) nodes to multiple Core Network (CN) nodes (Release 5)," 3GPP TS 23.236 V5.4.0 (Sep. 2005).
Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; Intra-domain connection of Radio Access Network (RAN) nodes to multiple Core Network (CN) nodes (Release 6)," 3GPP TS 23.236 V6.3.0 (Mar. 2006).
Nokia, "LTE Mobility Signalling," 3GPP TSG-RAN WG2 Meeting #53, R2-061137 (May 8-12, 2006).
Nokia, "I-RAT HO principles from E-UTRAN point of view," 3GPP TSG SA WG2, S2-070338, Florence, Italy (Jan. 15-19, 2007).
Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; 3GPP System Architecture Evolution: Report on Technical Options and Conclusions (Release 7)," 3GPP TR 23.882 V1.6.1 (Nov. 2006).
Third Generation Partnership Project, "Technical Specification Group Services and System Aspects; 3GPP System Architecture Evolution: Report on Technical Options and Conclusions (Release 7)," 3GPP TR 23.882 V1.14.0 (Jan. 2008).
ZTE Corporation, "Active mobility solution for SAE accessed from UMTS ," 3GPP TSG SA WG2 Architecture—S2#52, S2-061496, Shanghai, China (May 8-12, 2006).
"Chinese Office Action", Chinese Application No. 200820004751.3, dated Nov. 30, 2011, 5 pages.
"Chinese Office Action (English Translation)", Chinese Application No. 200880004751.3, dated Nov. 30, 2011, 8 pages.
"Japanese Notice of Rejection", Japanese Application No. 2014-100722, dated Feb. 17, 2015, 3 pages.
"Japanese Notice of Rejection", Japanese Application No. 2012-113519, dated Sep. 3, 2013, 4 pages.
"Japanese Notice of Rejection (English Translation)", Japanese Application No. 2012-113519, dated Feb. 17, 2015, 3 pages.
"Japanese Notice of Rejection (English Translation)", Japanese Application No. 2014-100722, dated Feb. 17, 2015, 3 pages.
"Korean Office Action", Korean Application No. 10-2009-7018868, dated Mar. 2, 2011, 3 pages.
"Korean Office Action (English Translation)", Korean Application No. 10-2009-7018868, dated Mar. 2, 2011, 6 pages.
Nokia, "LTE Mobility Signalling", 3GPP Tdoc R2-061137, 3GPP TSG-RAN WG2 Meeting #53, Shanghai, China, May 8-12, 2006, 5 pages.
"Korean Office Action", Korean Application No. 10-2014-7025776, dated Jul. 28, 2015, 3 pages.
"Korean Office Action (English Translation)", Korean Application No. 10-2014-7025776, dated Jul. 28, 2015, 4 pages.
"First Examination Report", Indian Application No. 5212/DELNP/2009, dated Sep. 10, 2015, 2 pages.
"Official Notice of Rejection", Japanese Application No. 2012-113519, dated Apr. 26, 2016, 22 pages.
"Official Notice of Rejection (English Translation)", Japanese Application No. 2012-113519, dated Apr. 26, 2016, 24 pages.
Huawei, "Inter RAT handover procedures between 3GPP access systems", 3GPP Tdoc S2-070078, 3GPP TSG SA WG2 Architecture—S2#56, Florence, Italy, Jan. 15-19, 2007, 12 pages.
Nokia, "MME/UPE Relocation in Inter-PLMN Handover", 3GPP Tdoc S2-070339, 3GPP TSG-SA WG2 Meeting #56, Florence, Italy, Jan. 15-19, 2007, 4 Pages.
Siemens, Nokia, "51 Handover functions and procedures", 3GPP Tdoc R3-070284, TSG RAN WG3 Meeting #55, St. Louis, Missouri, USA, Feb. 12-16, 2007, 6 pages.
"Changes to enable the GSMA root DNS architecture", 3GPP Tdoc N4-030876 Change Request, 3GPP TSG CN WG4 Meeting #20 Sophia Antipolis, France, Aug. 25-29, 2003, 7 pages.
"Official Notice of Rejection", Japanese Patent Application No. 2014-100722, dated Nov. 15, 2016, 17 pages.
"Official Notice of Rejection (English Translation)", Japanese Patent Application No. 2014- 100722, dated Nov. 15, 2016, 14 pages.
"Official Notice of Rejection", Japanese Patent Application No. 2016-166095, Jan. 6, 2017, 3 pages.
"Official Notice of Rejection (English Translation)", Japanese Patent Application No. 2016-166095, Jun. 6, 2017, 4 pages.
"Options for user plane handling in LTE-GERAN handovers", 3GPP Workshop LTE GSM, LGW-070027 Sophia Antipolis, Jan. 10-11, 2007, 8 pages.

(56) **References Cited**

OTHER PUBLICATIONS

"Options for user plane handling in LTE-GERAN handovers", 3GPP Workshop LTE GSM, LGW-070024, Sophia Antipolis, Jan. 10-11, 2007, 8 pages.

Nortel, "New Attach procedure with agreement on S5a", 3GPP Tdoc S2-070356, 3GPP TSG SA WG2 Architecture—S2#56, Jan. 15-19, 2007, 5 pages.

* cited by examiner

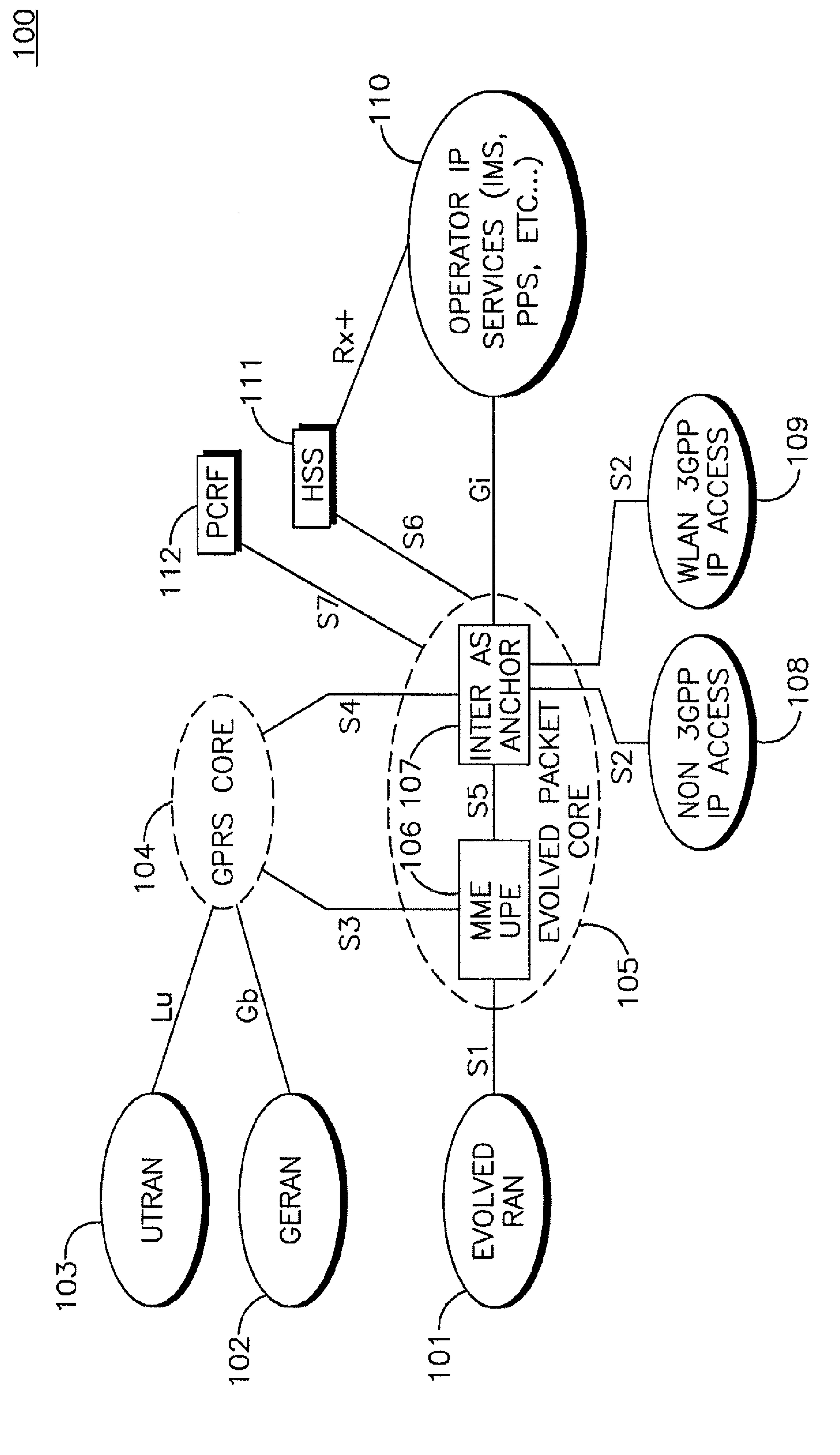

100
OPERATOR IP SERVICES (IMS, PPS, ETC...)
110
Rx+
111
HSS
112
PCRF
S7
S6
Gi
S2
WLAN 3GPP IP ACCESS
109
NON 3GPP IP ACCESS
108
S2
INTER AS ANCHOR
106 107
S4
S5
GPRS CORE
104
MME UPE
EVOLVED PACKET CORE
105
S3
Lu
Gb
S1
UTRAN
103
GERAN
102
EVOLVED RAN
101

FIG.1

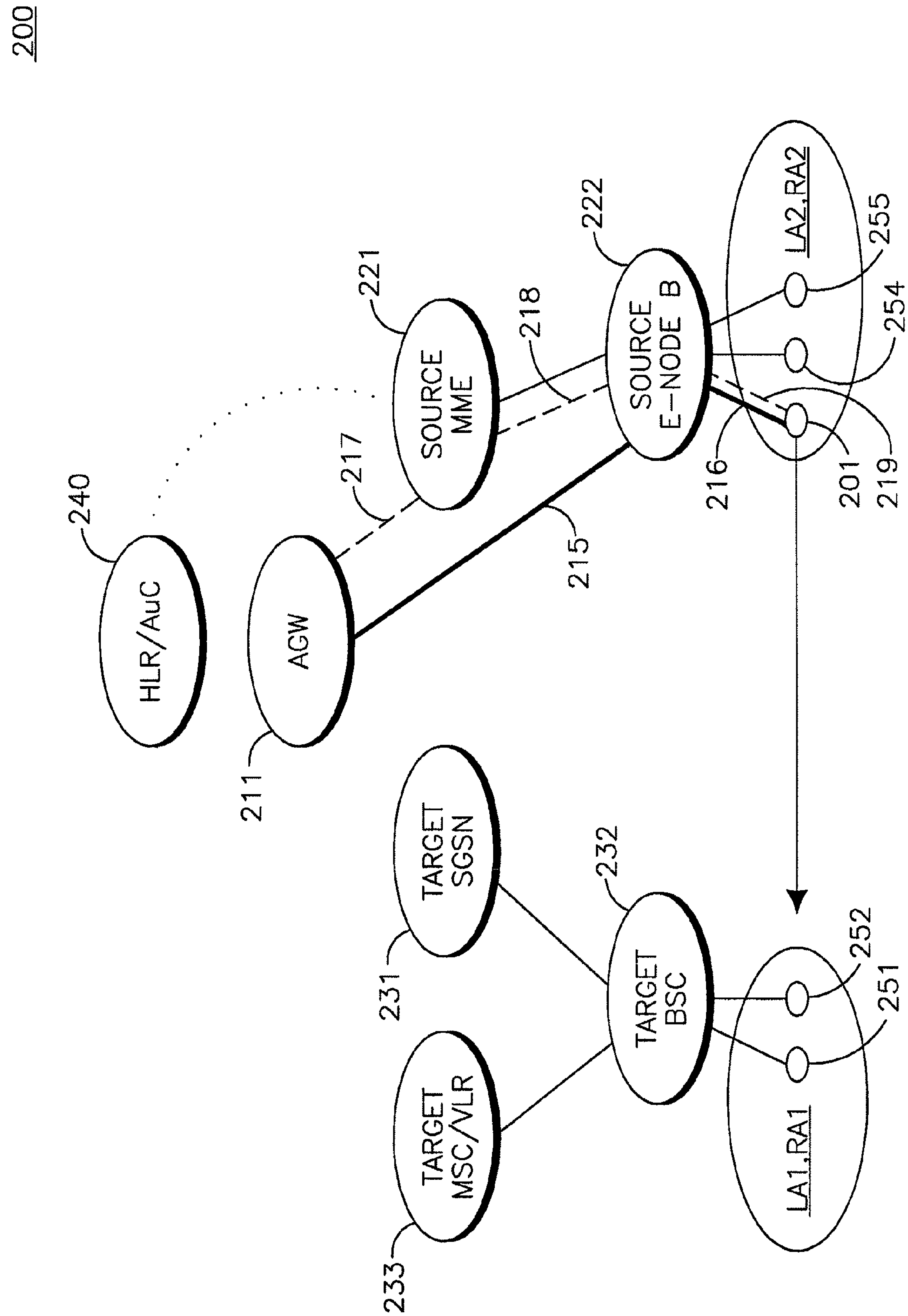

200
HLR/AuC
240
AGW
211
SOURCE MME
221
SOURCE E–NODE B
222
217
218
215
216
201
219
254
255
LA2,RA2
TARGET SGSN
231
TARGET BSC
232
TARGET MSC/VLR
233
252
251
LA1,RA1

FIG.2

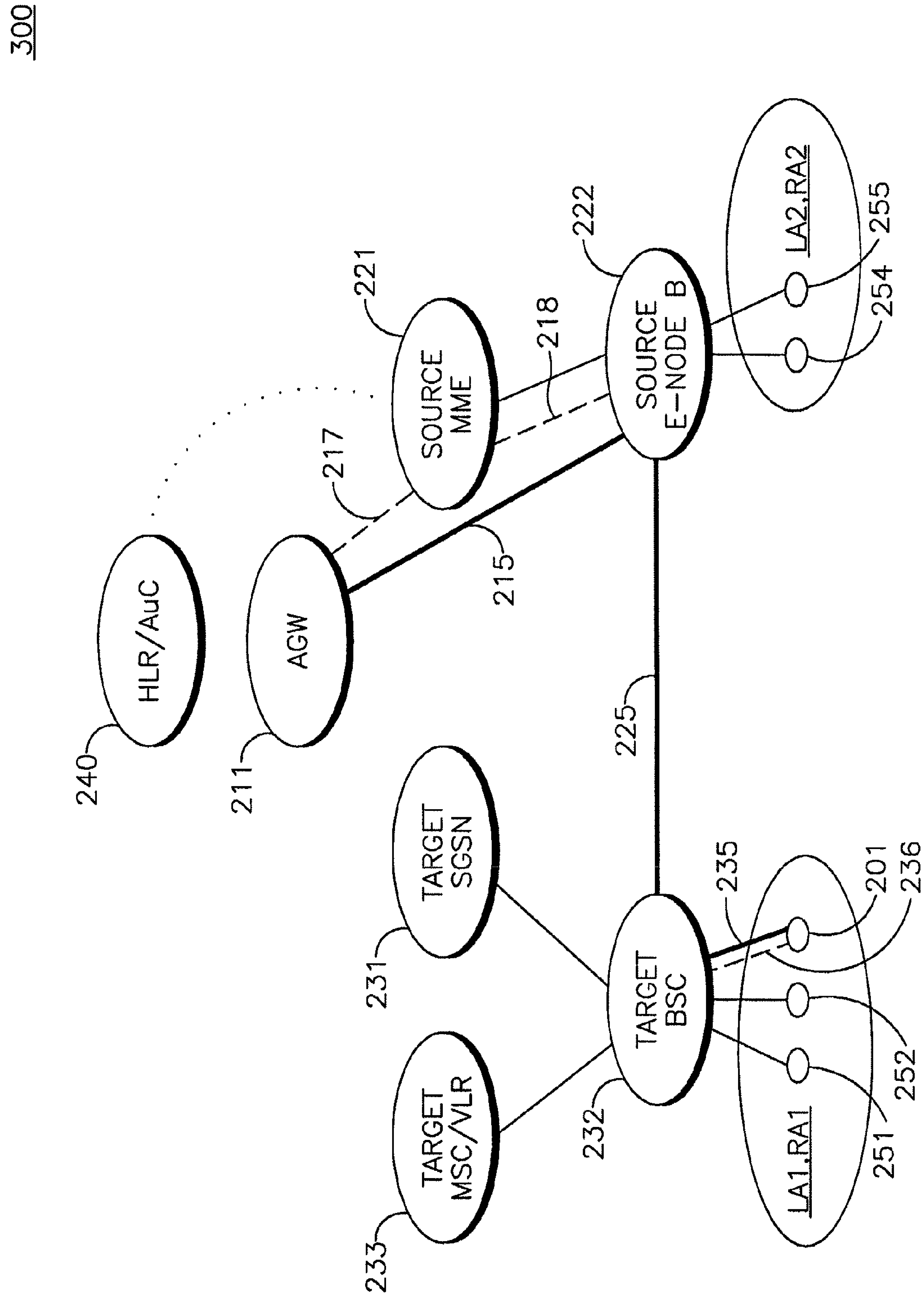

300
HLR/AuC
240
AGW
211
SOURCE MME
221
SOURCE E-NODE B
222
217
218
215
225
LA2,RA2
254
255
TARGET SGSN
231
TARGET MSC/VLR
233
TARGET BSC
232
235
201
236
252
251
LA1,RA1

FIG.3

400

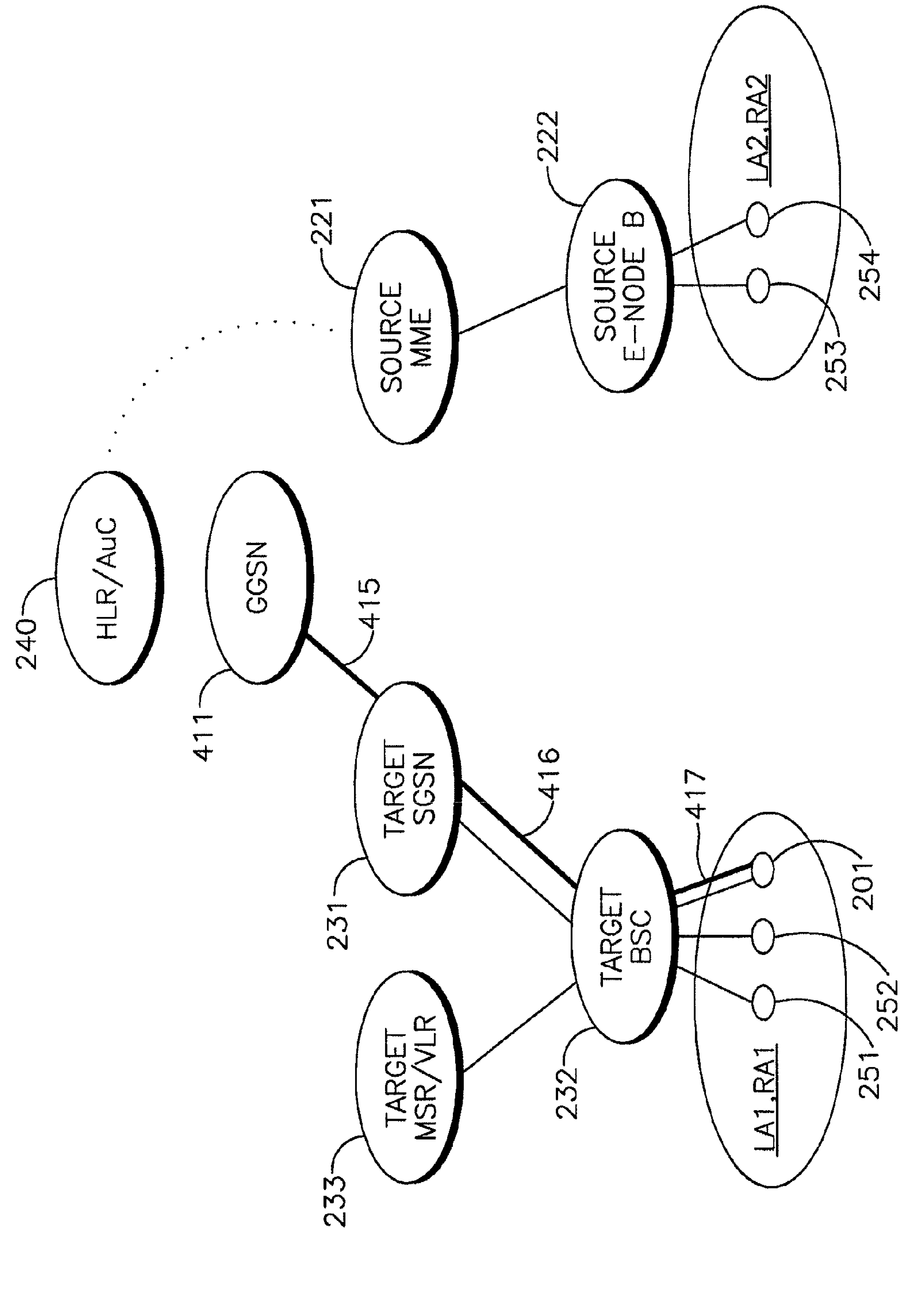

HLR/AuC
GGSN
SOURCE MME
SOURCE E-NODE B
LA2,RA2
TARGET SGSN
TARGET BSC
TARGET MSR/VLR
LA1,RA1
240
411
415
221
222
253
254
231
416
417
201
252
251
232
233

FIG.4

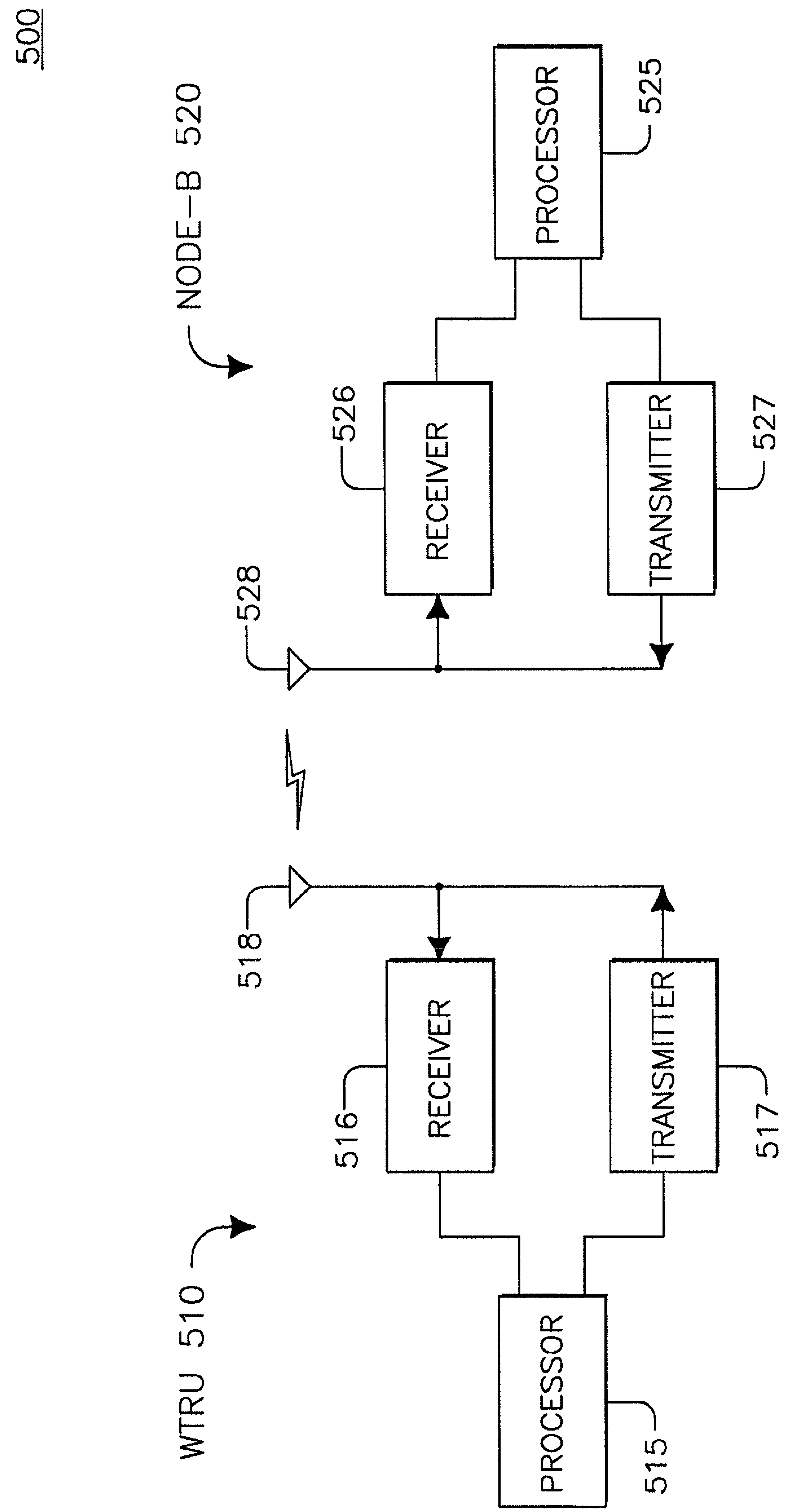
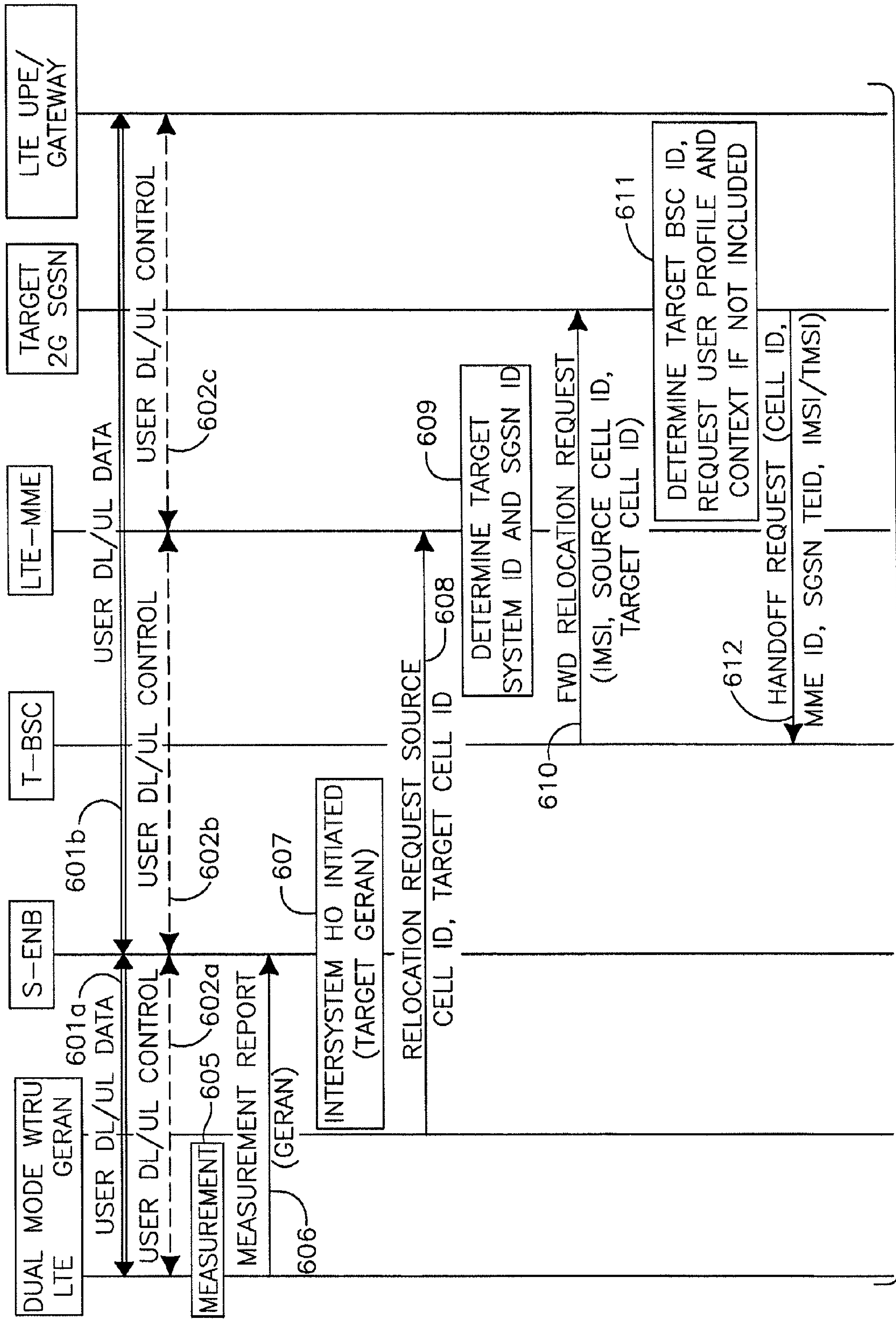

500
NODE—B 520
PROCESSOR
525
526
RECEIVER
TRANSMITTER
527
528
518
RECEIVER
TRANSMITTER
516
517
WTRU 510
PROCESSOR
515

FIG.5



TO FIG. 6B

FIG.6A

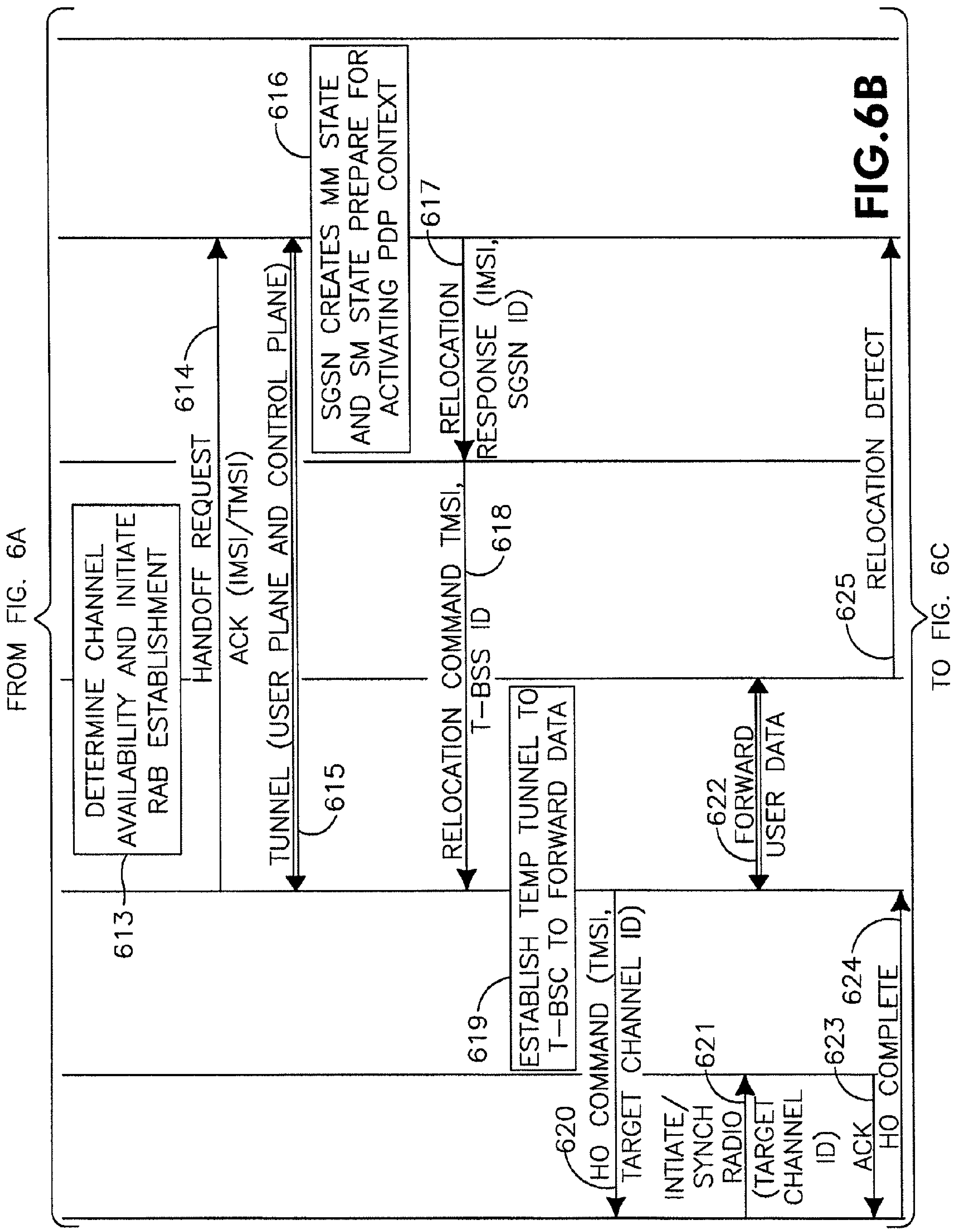

FROM FIG. 6A
613
DETERMINE CHANNEL AVAILABILITY AND INITIATE RAB ESTABLISHMENT
614
HANDOFF REQUEST
ACK (IMSI/TMSI)
615
TUNNEL (USER PLANE AND CONTROL PLANE)
616
SGSN CREATES MM STATE AND SM STATE PREPARE FOR ACTIVATING PDP CONTEXT
617
RELOCATION RESPONSE (IMSI, SGSN ID)
618
RELOCATION COMMAND TMSI, T-BSS ID
619
ESTABLISH TEMP TUNNEL TO T-BSC TO FORWARD DATA
620
HO COMMAND (TMSI, TARGET CHANNEL ID)
621
INTIATE/ SYNCH RADIO (TARGET CHANNEL ID)
622
FORWARD USER DATA
623
ACK
624
HO COMPLETE
625
RELOCATION DETECT
TO FIG. 6C

FIG.6B

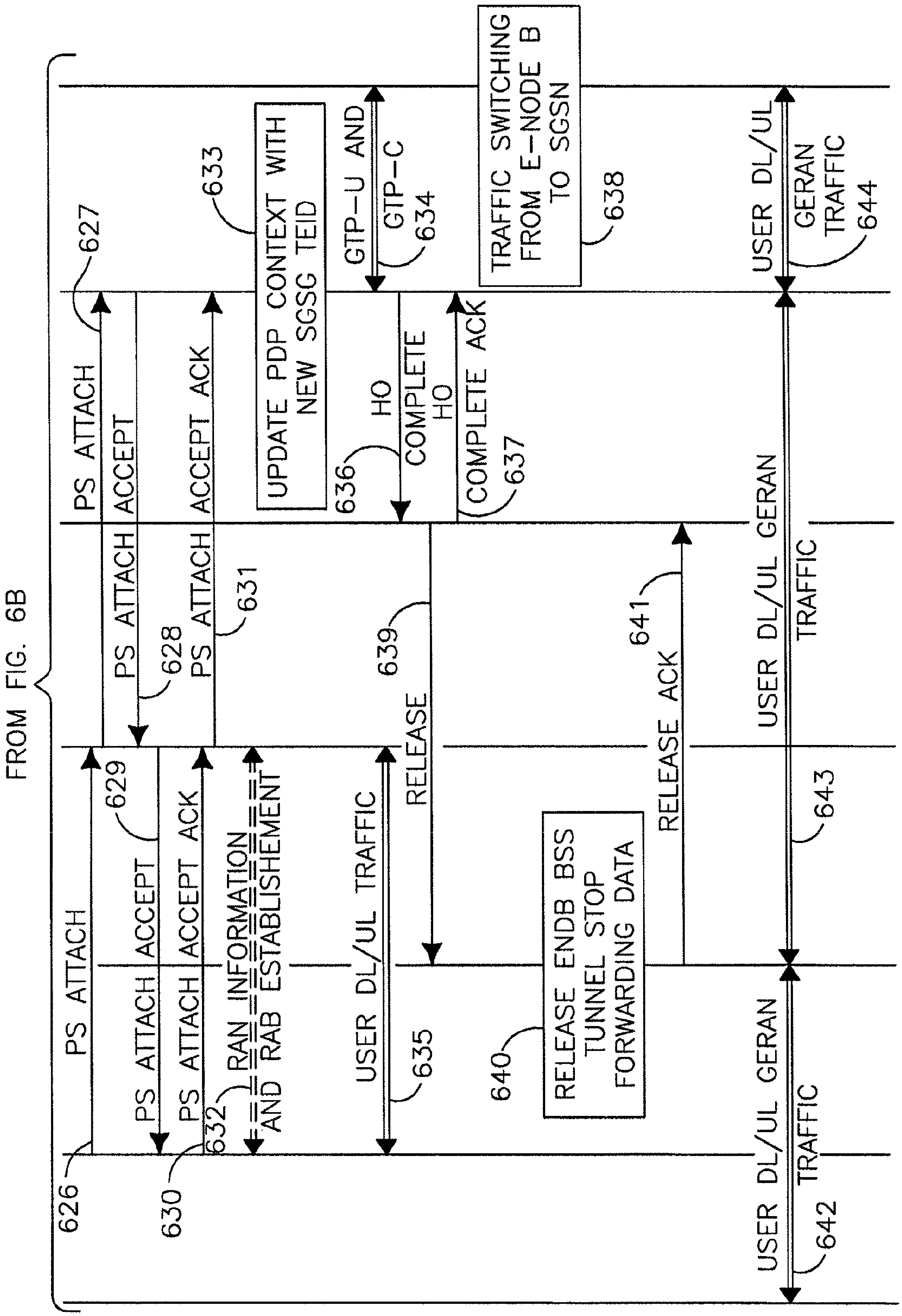

FROM FIG. 6B
PS ATTACH
626
PS ATTACH ACCEPT
630
PS ATTACH ACCEPT ACK
RAN INFORMATION AND RAB ESTABLISHEMENT
632
USER DL/UL TRAFFIC
635
RELEASE ENDB BSS TUNNEL STOP FORWARDING DATA
640
USER DL/UL GERAN TRAFFIC
642
629
PS ATTACH
628
PS ATTACH ACCEPT
631
PS ATTACH ACCEPT ACK
RELEASE
639
RELEASE ACK
641
USER DL/UL GERAN TRAFFIC
643
627
UPDATE PDP CONTEXT WITH NEW SGSG TEID
633
HO COMPLETE
636
HO COMPLETE ACK
637
GTP-U AND GTP-C
634
TRAFFIC SWITCHING FROM E-NODE B TO SGSN
638
USER DL/UL GERAN TRAFFIC
644

FIG.6C

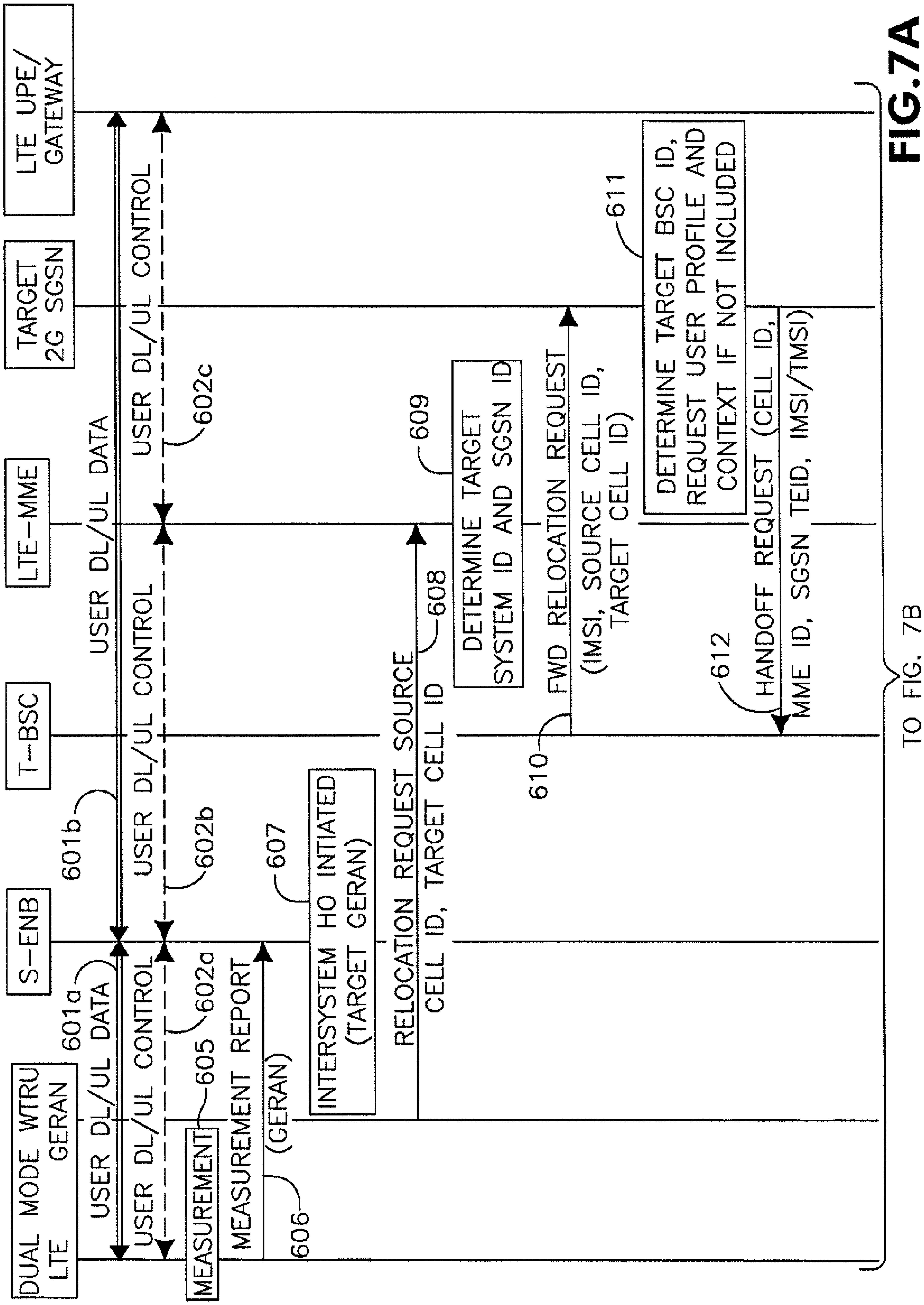

DUAL MODE WTRU
LTE GERAN
S-ENB
T-BSC
LTE-MME
TARGET 2G SGSN
LTE UPE/ GATEWAY
USER DL/UL DATA
601a
601b
USER DL/UL CONTROL
602a
602b
602c
MEASUREMENT
605
MEASUREMENT REPORT (GERAN)
606
INTERSYSTEM HO INTIATED (TARGET GERAN)
607
RELOCATION REQUEST SOURCE CELL ID, TARGET CELL ID
608
DETERMINE TARGET SYSTEM ID AND SGSN ID
609
FWD RELOCATION REQUEST (IMSI, SOURCE CELL ID, TARGET CELL ID)
610
DETERMINE TARGET BSC ID, REQUEST USER PROFILE AND CONTEXT IF NOT INCLUDED
611
HANDOFF REQUEST (CELL ID, MME ID, SGSN TEID, IMSI/TMSI)
612
TO FIG. 7B

FIG.7A

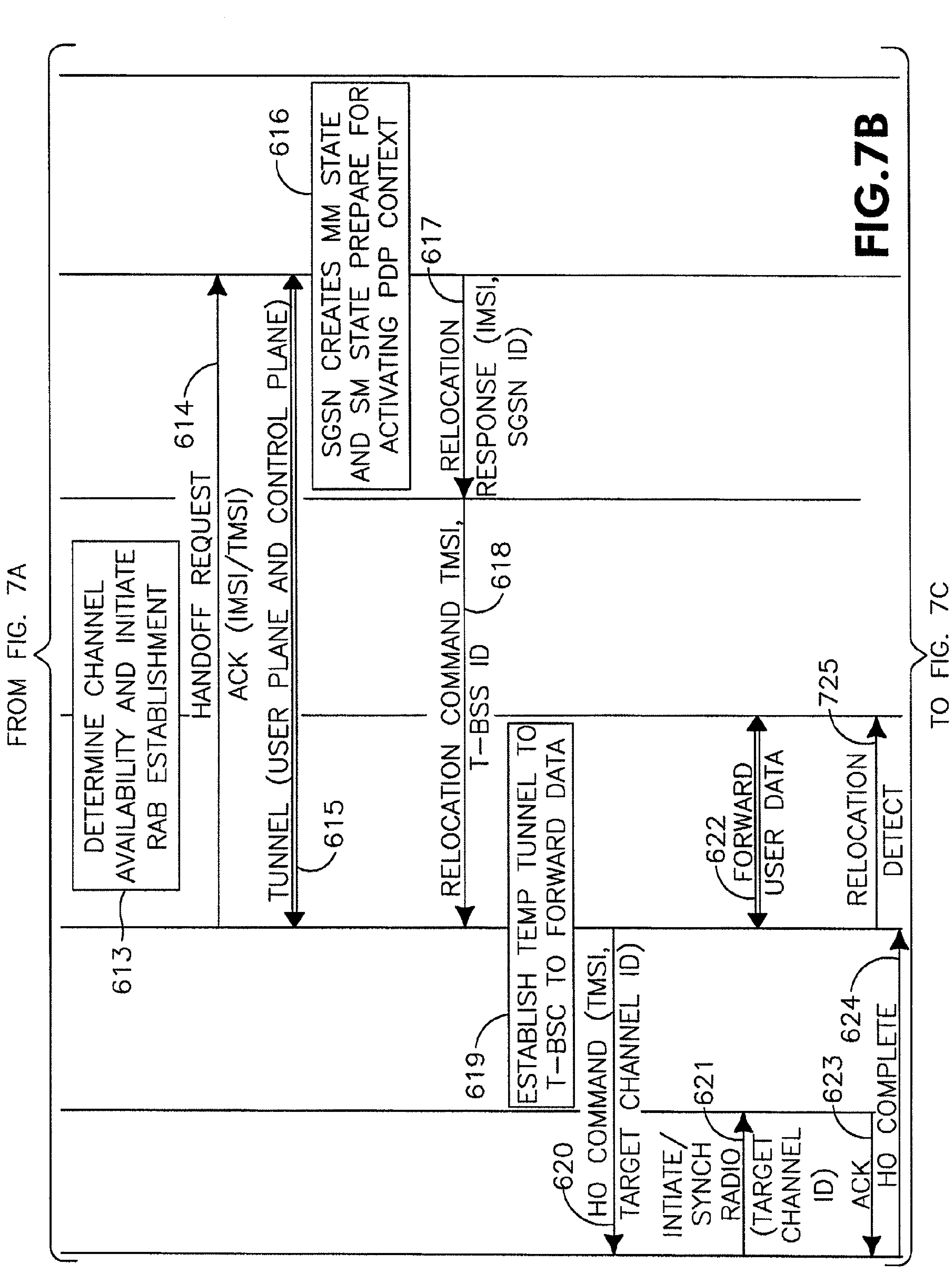

FROM FIG. 7A
613
DETERMINE CHANNEL AVAILABILITY AND INITIATE RAB ESTABLISHMENT
614
HANDOFF REQUEST
ACK (IMSI/TMSI)
615
TUNNEL (USER PLANE AND CONTROL PLANE)
616
SGSN CREATES MM STATE AND SM STATE PREPARE FOR ACTIVATING PDP CONTEXT
617
RELOCATION RESPONSE (IMSI, SGSN ID)
618
RELOCATION COMMAND TMSI, T-BSS ID
619
ESTABLISH TEMP TUNNEL TO T-BSC TO FORWARD DATA
620
HO COMMAND (TMSI, TARGET CHANNEL ID)
621
INTIATE/ SYNCH RADIO (TARGET CHANNEL ID)
622
FORWARD USER DATA
623
ACK
624
HO COMPLETE
725
RELOCATION DETECT
TO FIG. 7C

FIG.7B

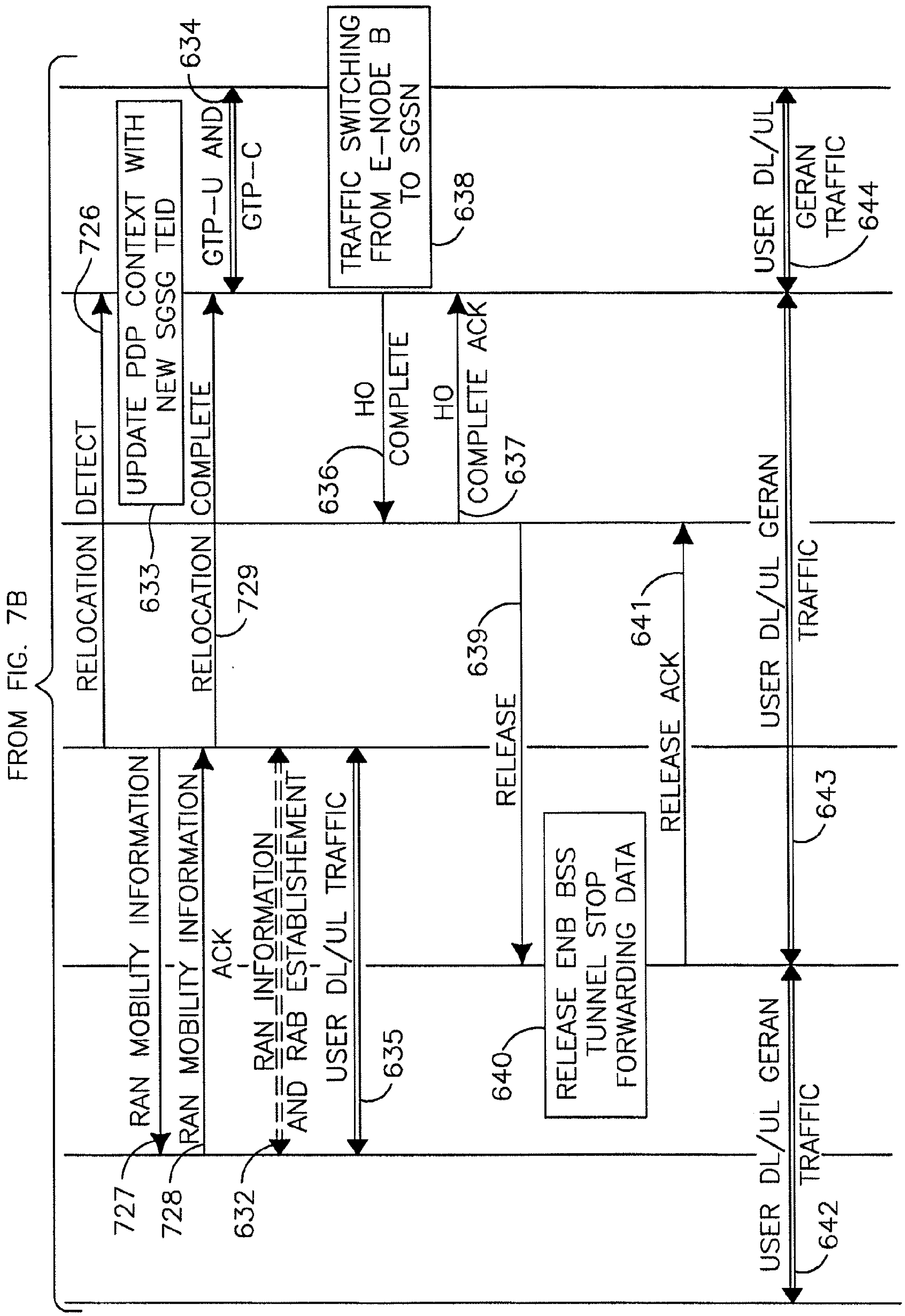

FROM FIG. 7B
RAN MOBILITY INFORMATION
RAN MOBILITY INFORMATION ACK
RAN INFORMATION AND RAB ESTABLISHEMENT
USER DL/UL TRAFFIC
RELOCATION DETECT
UPDATE PDP CONTEXT WITH NEW SGSG TEID
RELOCATION COMPLETE
GTP-U AND GTP-C
TRAFFIC SWITCHING FROM E-NODE B TO SGSN
HO COMPLETE
HO COMPLETE ACK
RELEASE
RELEASE ENB BSS TUNNEL STOP FORWARDING DATA
RELEASE ACK
USER DL/UL GERAN TRAFFIC
USER DL/UL GERAN TRAFFIC
USER DL/UL GERAN TRAFFIC
727
728
632
635
726
633
729
634
636
637
638
639
640
641
642
643
644

FIG.7C

METHOD AND APPARATUS FOR SUPPORTING HANDOVER FROM LTE/EUTRAN TO GPRS/GERAN

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 12/029,532 filed Feb. 12, 2008, which issues as U.S. Pat. No. 8,072,936 on Dec. 6, 2011, which claims the benefit of U.S. Provisional Application No. 60/889,383, filed Feb. 12, 2007, the contents of which are hereby incorporated by reference herein.

FIELD OF INVENTION

This application is related to wireless communications.

BACKGROUND

There are different types of wireless communication systems. For example, some wireless communication systems include general packet radio service (GPRS), global system for mobile (GSM)/enhanced data rates for GSM evolution (EDGE) radio access network (GERAN), and the newly introduced long term evolution (LTE) evolved universal terrestrial radio access network (EUTRAN). LTE/EUTRAN system has a different physical layer and a different architecture from those systems preceding it, i.e., GPRS, GERAN, or UTRAN.

When a Multi-mode mobile unit is traveling across the geographic coverage of these different systems, it may need to be handed off from one network to another. Since not all networks are identical, a method for supporting the handover between systems would be beneficial.

FIG. **1** shows an exemplary diagram of a system **100** including an LTE system architecture. The system **100** shows an LTE/EUTRAN **101** and its evolved packet core **105** interworking with an existing GERAN **102**, UTRAN **103**, and their GPRS Core **104**. The LTE/EUTRAN **101** comprises an E-Node B (not shown) that is connected (S1) to an evolved packet core **105** containing a mobility management entity/user plane entity (MME/UPE) **106** and an inter AS anchor Gateway **107**. The Evolved Packet Core **105** connects (S6) to a home subscriber service (HSS) **111**, and connects (S7) to a Policy and Charging Rules (PCRF) **112**. The inter AS Anchor gateway **107** connects (Gi) to Operator IP Servers (such as IMS, PSS) **110**, connects (S2) to a Non-3GPP IP Access network **108**, and connects (S2) to a WLAN 3GPP IP Access network **109**. The GPRS Core **104** comprises a Serving GPRS Support Node (SGSN) (not shown) which is responsible for Mobility Management, Access Procedures, and User Plane Control. The GPRS Core **104** also comprises a Gateway GPRS Support Node (GGSN), where the network is connected to external networks and other operator servers. The Operator IP Servers **110** may include an IP Multimedia Service Subsystem (IMS) where VoIP and other multimedia services are controlled. The Non-3GPP IP access network **108** includes connections to other technologies that are developed in other standard Forums such as 3GPP2 (CDMA2000) and WiMAX (IEEE 802.16 system). The WLAN 3GPP IP access network **109** has WLANs incorporated into 3GPP systems via interworking architecture defined in 3GPP.

SUMMARY

A method and apparatus for supporting handover from an LTE/EUTRAN cell to a general packet radio service (GPRS)/global system for mobile communications (GSM)/enhanced data rates for GSM evolution (EDGE) radio access network (GERAN) cell. In one embodiment, a GERAN access procedure during the handover includes sending a packet switched (PS) attach signal. In another embodiment, the GERAN access procedure includes RAN mobility information messages being exchanged between the WTRU and a target base station controller (T-BSC).

BRIEF DESCRIPTION OF THE DRAWINGS

A more detailed understanding may be had from the following description, given by way of example in conjunction with the accompanying drawings wherein:

FIG. **1** shows an example of an LTE general network architecture;

FIG. **2** shows an initial state for handoff from an LTE system to a GPRS/GERAN system;

FIG. **3** shows a second state for handoff from an LTE system to a GPRS/GERAN system;

FIG. **4** shows a third state for handoff from an LTE system to a GPRS/GERAN system;

FIG. **5** shows a functional block diagram of a wireless transmit/receive unit and a Node B;

FIGS. **6**A, **6**B, **6**C show a signal flow diagram of a handover procedure including a packet switched (PS) handover signal; and

FIGS. **7**A, **7**B, **7**C show a signal flow diagram of a handover procedure including a relocation detect from a source evolved Node-B (S-ENB) to a target base station controller (T-BSC).

DETAILED DESCRIPTION

When referred to hereafter, the terminology "wireless transmit/receive unit (WTRU)" includes but is not limited to a user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a computer, or any other type of user device capable of operating in a wireless environment. When referred to hereafter, the terminology "base station" includes but is not limited to a Node-B, a site controller, an access point (AP), or any other type of interfacing device capable of operating in a wireless environment.

FIGS. **2**-**4** show examples of three states of traffic paths and tunnels established between network entities during a handover of a WTRU from an LTE network to a GERAN network. In FIG. **2**, an initial state **200** is shown for a mobile WTRU **201** moving from an LTE network cell designated as local area LA2/Routing Area RA2, to a GERAN system LA1/RA1. The cells belonging to GERAN systems may constitute different Location Area/Routing Area (LA1/RA1) from those belonging to LTE based cells (LA2/RA2). In certain deployments, although GERAN cells may be co-located with GERAN cells, these cells will remain under different LA/RA configuration due to the difference between the two system architectures. Other WTRUs **254**, **255** are shown camped on the cell LA2/RA2, and WTRUs **251**, **252** are camped on the cell LA1/RA1. The WTRU is currently connected to an access gateway **211** via a source Evolved Node B (ENB) **222**, where tunnels **215** and **216** are established for the user data plane. Source mobility management entity (MME) **221** controls mobility and handles user control plane traffic on tunnels **217** and **218**. User control plane traffic is connected on tunnel **219** between the source ENB **222** and the WTRU **201**. The target GERAN system comprises a target SGSN **231**, a target base station controller

(BSC) **232**, and a target mobile services switching center/visitor location register (MSC/VLR) entity **233**.

FIG. **3** shows an optional second state **300** for tunneling of network entities during the handover of the WTRU **201** from the LTE network cell LA2/RA2 to the GERAN cell LA1/RA1. The WTRU **201** is now migrated to the GERAN cell LA1/RA1.

An optional tunnel **225** may be created between the target BSC **232** of the GERAN system and the source ENB **222**. The tunnel **225** may be used to temporarily forward the current pending data transfer between GERAN system and the WTRU via E-Node B while a new connection between the Evolved Core Network **105** and the GPRS Core **104** (i.e., while the backbone procedures to switch traffic is completed). This will ensure that no data is lost during transition. A system operator may choose not to implement this step and go to a complete transition case where no connection is established between the GERAN BSC **232** and ENB **222**. In such a case, forwarding of data occurs at higher layers, between the two core networks on S3 and S4 connections. The user data plane and control plane traffic is carried to the WTRU **201** across the tunnels **235** and **236**, respectively.

FIG. **4** state **400** for tunneling of network entities during the handover of the WTRU **201** from the LTE network cell LA2/RA2 to the GERAN cell LA1/RA1. As shown in FIG. **4**, the traffic switching has occurred in the upper layers such that the GERAN system is now is the network source for user traffic, as shown by GGSN **411**. The WTRU **201** is now connected to the GERAN system GGSN **411** via the Target SGSN **231**, and the target BSC **232**, on user data plane and control plane tunnels **415**, **416** and **417**, respectively.

FIG. **5** is a functional block diagram of a WTRU **510** and a Node B **520**. As shown in FIG. **5**, the WTRU **510** is in communication with the Node B **520** and both are configured to support handover from GPRS/GERAN to LTE/EUTRAN.

In addition to the components that may be found in a typical WTRU, the WTRU **510** includes a processor **515**, a receiver **516**, a transmitter **517**, and an antenna **518**. The processor **515** is configured to support handover from GPRS/GERAN to LTE/EUTRAN. The receiver **516** and the transmitter **517** are in communication with the processor **515**. The antenna **518** is in communication with both the receiver **516** and the transmitter **517** to facilitate the transmission and reception of wireless data. The processor **515**, receiver **516**, transmitter **517**, and antenna **518** may be configured as a GPRS/GERAN radio transceiver, or configured as an LTE/EUTRAN radio transceiver. Also, although only one processor, receiver, transmitter, and antenna is shown, it should be noted that multiple processors, receivers, transmitters, and antennas may be included in the WTRU **510**, whereby different groupings of processors, receivers, transmitters, and antennas operate in different modes, (e.g., GPRS/GERAN transceiver or LTE/EUTRAN transceiver).

In addition to the components that may be found in a typical Node B, the Node B **520** includes a processor **525**, a receiver **526**, a transmitter **527**, and an antenna **528**. The processor **525** is configured to support handover from LTE/EUTRAN to GERAN. The receiver **526** and the transmitter **527** are in communication with the processor **525**. The antenna **528** is in communication with both the receiver **526** and the transmitter **527** to facilitate the transmission and reception of wireless data.

In a first embodiment, GERAN access procedures include packet switched (PS) attach signals between the LTE transceiver of the WTRU **510**. FIGS. **6**A-**6**C show an exemplary signal diagram of a handover procedure **600** for this embodiment. While the following signals are shown in FIGS. **6**A-**6**C and described in a particular sequence, the signals may occur in variations to the sequence in accordance with this embodiment.

In the signal diagram of FIGS. **6**A-**6**C, signals are exchanged among: a dual mode LTE/GERAN WTRU having an LTE transceiver and a GERAN transceiver, each transceiver comprising a receiver and a transmitter; a source e-Node B (S-ENB); a target BSC (T-BSC); a source LTE-MME; a target SGSN; and an LTE UPE/Gateway. The dual mode WTRU in this example includes an LTE and GERAN transceiver.

As shown in FIGS. **6**A-**6**C, user downlink (DL) and uplink (UL) traffic **601**a, **601**b is exchanged between the WTRU LTE transceiver, the S-ENB and the LTE UPE/Gateway. The WTRU LTE transceiver performs measurements **605** on LTE frequencies and GERAN frequencies, and transmits a GERAN measurement report signal **606** to the S-ENB. The WTRU may receive a list of different radio access technologies, including GERAN, from the S-ENB to identify the types of frequency measurements to undertake. Intersystem Handover **607** is initiated by the S-ENB, which makes the handover decision based on the measurement report **606**, with GERAN being the target. A relocation request signal **608**, containing the source cell ID and the target cell ID, is transmitted from the S-ENB to the source MME. The source MME makes a determination **609** of the target system cell ID and the SGSN ID by mapping the target cell ID (GERAN) to an SGSN IP address. The source MME forwards the relocation request **610** to the target SGSN, including an international mobile subscriber identity (IMSI), source cell ID and target cell ID.

The target SGSN performs a determination **611** of the target BSC ID, and requests the user profile and context if it was not included in signaling message **610**. The target SGSN sends a handover request signal **612** to the T-BSC, including the cell ID, SGSN ID, and the international mobile subscriber identity/temporary mobile subscriber identity (IMSI/TMSI). The T-BSC performs a determination **613** of channel availability and initiates radio access bearer (RAB) establishment. The T-BSC transmits a handoff request ACK **614**, including the IMSI/TMSI, to the Target SGSN. A user plane and control plane tunnel **615** is established between the T-BSC and the Target SGSN. The target SGSN creates an MM state and SM state **616** to prepare for activating packet data protocol (PDP) context information.

The target SGSN sends a relocation response **617** including an IMSI and SGSN ID, to the Source MME, which sends a relocation command signal **618**, that includes the TMSI and target BSC ID to the S-ENB. A temporary tunnel **619** to the T-BSC is established by the S-ENB to forward user data to the T-BSC. A handover command **620** is transmitted from the source MME to the S-ENB, and is forwarded to the WTRU LTE transceiver, which recognizes the target GERAN technology amongst others that may be supported, and an initiate/synch radio signal **621**, including a target channel ID, is communicated to the WTRU GERAN transceiver. The GERAN transceiver sends an ACK signal **623**. User data **622** is exchanged on the temporary tunnel **619** between the S-ENB and the T-BSC. A handover complete signal **624** is sent from the WTRU LTE transceiver to the S-ENB. The T-BSC sends a relocation detect signal **625** to the target SGSN.

The GERAN access procedure includes a PS attach signal **626** transmitted from the WTRU GERAN transceiver to the T-BSC, which forwards the PS attach signal **627** to the target

SGSN. A PS attach accepted signal **628** is returned by the target SGSN to the T-BSC. The WTRU GERAN transceiver is configured to receive a PS attach Accept **629** from the T-BSC, and to respond with a PS attach accept ACK **630**. The T-BSC forwards a PS attach accept ACK signal **631** to the target SGSN.

The target SGSN performs an update **633** of the PDP context with the new SGSN TEID, and establishes a tunnel **634** with the LTE UPE/gateway for a GPRS tunneling protocol user plane and control plane (GTP-U and GTP-C). At this stage the user plane path is established for all PDP contexts between the WTRU GERAN transceiver, Target BSC, Target SGSN, and serving gateway. The switch of traffic **638** is complete from the source ENB to the target SGSN. Between the WTRU GERAN transceiver and T-BSC, a tunnel **632** is established for exchange of RAN information and RAB establishment, and user DL/UL traffic **635** is exchanged.

A handover complete signal **636** is sent from the target SGSN to the source MME, which sends a release signal **639** to the S-ENB and an HO complete ACK **637** to the target SGSN. The S-ENB performs a release **640** of its resources related to the WTRU, and stops forwarding data. A release ACK **641** is transmitted from the S-ENB to the source MME, and user DL/UL GERAN traffic now flows on tunnel **642** between the WTRU GERAN transceiver and the target BSC, on tunnel **643** between the T-BSC and the target SGSN, and on tunnel **644** between the target SGSN and the GGSN gateway.

FIGS. **7**A-**7**C show a signaling diagram according to a second embodiment in which the GERAN access procedure includes a relocation detect signal from the source ENB and the target BSC, and RAN mobility information signals. In this embodiment, the signals are similar to the first embodiment as shown in FIGS. **6**A, **6**B and **6**C, except for the following signals which are used in lieu of the PS attach signals **626**-**631** excluded in this embodiment.

As shown in FIGS. **7**A-**7**C, a GERAN access procedure begins the handover complete signal **624**. A relocation detect signal **725** is sent by the S-ENB to the T-BSC, and a relocation detect signal **726** is forwarded from the T-BSC to the target SGSN. RAN mobility information **727** is transmitted by the T-BSC to the WTRU GERAN transceiver, which returns a RAN mobility information ACK **728**. The T-BSC sends a Relocation complete signal **729** to the target SGSN.

As described in FIGS. **1**-**7**C above, radio resources are prepared in the target 3GPP access system before the WTRU **510** is commanded by the source 3GPP access system to change to the target 3GPP access system. A tunnel is established between the two radio access networks (RANs) (basic service set (BSS)/basic service controller (BSC) and E-Node B) in order to forward the data while the core network resources are assigned.

A control interface may exist in the core level between the 2 G/3 G SGSN and corresponding MME to exchange the mobility context and the session context of the Mobile. Additionally, the target system may provide directions to the WTRU as to the radio access requirements, such as the radio resource configuration, target cell system information, and the like.

There is an intermediate state during handoff where the DL User plane data is sent from source system to the target system before the User plane is switched directly to the target system in order to avoid the loss of user data, (e.g., by forwarding). Bi-casting may also be used until the 3GPP Anchor determines that it can send DL U-plane data directly to the target system.

Although features and elements are described above in particular combinations, each feature or element can be used alone without the other features and elements or in various combinations with or without other features and elements. The methods or flow charts provided herein may be implemented in a computer program, software, or firmware incorporated in a computer-readable storage medium for execution by a general purpose computer or a processor. Examples of computer-readable storage mediums include a read only memory (ROM), a random access memory (RAM), a register, cache memory, semiconductor memory devices, magnetic media such as internal hard disks and removable disks, magneto-optical media, and optical media such as CD-ROM disks, and digital versatile disks (DVDs).

Suitable processors include, by way of example, a general purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs) circuits, any other type of integrated circuit (IC), and/or a state machine.

A processor in association with software may be used to implement a radio frequency transceiver for use in a wireless transmit receive unit (WTRU), user equipment (UE), terminal, base station, radio network controller (RNC), or any host computer. The WTRU may be used in conjunction with modules, implemented in hardware and/or software, such as a camera, a video camera module, a videophone, a speakerphone, a vibration device, a speaker, a microphone, a television transceiver, a hands free headset, a keyboard, a Bluetooth® module, a frequency modulated (FM) radio unit, a liquid crystal display (LCD) display unit, an organic light-emitting diode (OLED) display unit, a digital music player, a media player, a video game player module, an Internet browser, and/or any wireless local area network (WLAN) or Ultra Wide Band (UWB) module.

What is claimed is:

1. A source long term evolution (LTE) mobility management entity (MME) for supporting a handover of a wireless transmit/receive unit (WTRU) from an LTE/Evolved Universal Terrestrial Radio Access Network (EUTRAN) to a General Packet Radio Service (GPRS)/Global System for Mobile (GSM) Enhanced Data Rates for GSM evolution (EDGE) Radio Access Network (GERAN), the source LTE MME comprising:

a processor, a memory configured to store instructions executed by the processor, a first interface, and a second interface,

wherein the first interface is configured to receive a relocation request signal message including information indicating a target cell identification (ID) and a source cell ID for the handover of the WTRU,

wherein the processor is configured to determine, in connection with the handover, an ID of a target GERAN system and an ID of a target serving General Packet Radio Service (GPRS) support node (SGSN) by mapping the target cell ID to an SGSN internet protocol (IP) address, wherein the target GERAN system comprises the target SGSN, and wherein the second interface is configured to:

(1) transmit a relocation request signal including an international mobile subscriber identity (IMSI), the source cell ID, and the target cell ID to the target SGSN,

(2) receive a relocation response signal including the IMSI and the target SGSN ID from the target SGSN, and

(3) transmit a relocation command signal including information indicating a temporary mobile subscriber identity (TMSI) and a target base station controller (BSC) ID to an evolved Node B (eNB).

2. The source LTE MME of claim **1**, wherein the second interface is configured to receive a handover complete signal from the target SGSN, to transmit a handover complete acknowledgment signal to the target SGSN, to transmit a release signal to an evolved Node B (eNB), and to receive a release acknowledgment signal from the eNB.

3. The source LTE MME of claim **1**, further comprising a receiver configured to: receive the relocation request message via the first interface.

4. The source LTE MME of claim **1**, further comprising a transmitter and a receiver, wherein:

the transmitter is configured to transmit the relocation request signal to the SGSN via the second interface;

the receiver is configured to receive the relocation response signal from the target SGSN via the second interface; and

the transmitter is configured to transmit the relocation command signal to the eNB via the second interface.

5. The source LTE MME of claim **1**, comprising a transmitter and a receiver, wherein:

the receiver is configured to receive the relocation request message via the first interface;

the transmitter is configured to transmit the relocation request signal to the SGSN via the second interface;

the receiver is configured to receive the relocation response signal from the target SGSN via the second interface; and

the transmitter is configured to transmit the relocation command signal to the eNB via the second interface.

6. A method for use in a source long term evolution (LTE) mobility management entity (MME) to support a handover of a wireless transmit/receive unit (WTRU), the method comprising:

receiving a relocation request signal including information indicating a target cell identification (ID) and a source cell ID for the handover of the WTRU from an evolved Node B (eNB);

determining, in connection with the handover, an ID of a target General Packet Radio Service (GPRS)/Global System for Mobile (GSM) Enhanced Data Rates for GSM evolution (EDGE) Radio Access Network (GERAN) system cell and an ID of a target serving General Packet Radio Service (GPRS) support node (SGSN) by mapping the target cell ID to an SGSN internet protocol (IP) address, wherein the target GERAN system comprises the target SGSN;

transmitting a relocation request signal including an international mobile subscriber identity (IMSP, the source cell ID, and the target cell ID to the target SGSN;

receiving a relocation response signal including the IMSI and the target SGSN ID from the target SGSN; and

transmitting a relocation command signal including information indicating a temporary mobile subscriber identity (TMSI) and a target base station controller (BSC) ID to the evolved Node B (eNB).

7. The method of claim **6**, further comprising:

receiving a handover complete signal from the target SGSN;

transmitting a handover complete acknowledgment signal to the target SGSN;

transmitting a release signal to the eNB; and

receiving a release acknowledgment signal from the eNB.

* * * * *